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Hedging Effectiveness on the Thailand Futures Exchange Market

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Abstract

This study examines hedge strategies through derivative instruments in an emerging market, with evidence from Thailand during the period 2011 to 2018. Focusing on a series of futures contracts on the Thailand Futures Exchange market (TFEX), namely SET50 futures, gold futures and interest rate futures, the study methods employed in both static and time-varying models: OLS, VECM, time-varying OLS, EGARCH, BEKK and DCC. In general, the results show that SET50 futures display the best hedge ratio and hedge effectiveness in Thailand, followed by gold futures and interest rate futures. Therefore, investors in Thailand will benefit from investing in SET50 futures only if their business or hedge assets relate to the composite index, particularly the SET50 index. Otherwise, the other types of derivatives or financial instruments may need to be considered more carefully for investment strategies. However, the hedge effectiveness of gold futures appears to be sensitive when the time-varying models are applied differently. Furthermore, these results are consistent with the previous literature and shed more light on the study of derivative products in Thailand.

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JEL Classification: G11, G13, G32, G39

1. Introduction

Risk is defined as anything which is different to expectations. In investment strategy, there are several risks that frequently occur, and investors would appreciate being able to minimise these as much as possible, including by hedging their investment risk. Due to the characteristics of risk-averse investors, reducing investment risks could be one way of effectively managing their portfolios, instead of expecting higher returns. The financial instruments used to hedge against risk are usually known as derivatives (Lee & Lee, 2012); for example, futures, forwards, swaps and options. Their characteristics are widely recognised as being able to hedge against risk due to their prices, which depend on underlying assets. Nevertheless, Gitman and Joehnk (2002) point out that investing in options and futures are two vehicles which contain the highest risk in risk-return trade-off. Consequently, a number of questions arise. For example, is it worth hedging via derivatives? And if so, to what extent is this approach effective and what hedging strategies should be applied?

This study makes an in-depth analysis of these questions, which arise when investors hedge their investment risk via derivatives. In particular, the research examines hedge effectiveness and the optimal hedge ratios through the derivatives market in an emerging market, with Thailand chosen as the case study. Since Thailand contains most of the characteristics of an emerging market, for instance high volatility and a low level of market capitalisation (Mody, 2004), the Thailand Futures Exchange (hereafter TFEX, known as the derivatives market of Thailand) has a limited variety of derivative products and futures which can serve as the focus of the study. In comparison with related studies of developed markets, such as in the US and EU, there are only a small number of studies of emerging markets, particularly Asia-Pacific ones. Therefore, it can be claimed that this is among the first papers to compare the hedge effectiveness of futures traded on the TFEX, although the study of Thailand by Amornsiripanuwat (2017) does consider Thai options.

The characteristics of options are totally different to those of derivatives contracts. While an option is a derivative, which gives the right to the option holders to exercise options based on their benefit, futures and other derivatives (for instance, forwards and swaps) are obligations to exchange underlying assets with unlimited gain or loss. Only one option contract has been recently traded on the TFEX, known as the SET50 index option. Amornsiripanuwat (2017) conducted a study to compare and capture hedge effectiveness using the models of Wilmott (1994) and Black and Scholes (1973), with data on the SET50 index option. His results show no differences in hedge effectiveness between the two specific models and he suggests continuing to use the Black and Scholes model since it remains popular. However, this evidence is slightly inconsistent with the work of Wattanatorn (2014), who estimates the performance of the SET50 index options using Black and Scholes's (1973) model and the Heston Stochastic Volatility model. Wattanatorn (2014) concludes that the latter appears to be a better fit for the Thai options market. Since there is only one option trading product on the TFEX, this study focuses on the major type of derivative products listed on the TFEX, which are futures. The selection of futures contracts on the TFEX is based on the period in which futures were first traded on it.

Furthermore, hedging strategy could be an interesting issue following the methods applied in this research, covering both the static and time-varying models. The study will provide necessary information for investment decisions on the TFEX, particularly for futures. With regard to the static model, the results of hedge effectiveness relate to a specific time, while the time-varying model relates to investment risk which appears to be dynamic. Although some Thai studies are concerned with derivatives (e.g. Wattanatorn, 2014; Amornsiripanuwat, 2017), they focus on options and finding the optimal hedge and models for options in Thailand. This research will provide a different view of futures, because theoretically there is no initial cost involved and they are fully traded on the exchange market, whereas options are traded both over-the-counter (OTC) and on the exchange market. However, the margin system in futures contracts is beyond the scope of this study.

An overview of the results shows that hedging via futures in Thailand appears to be an effective solution for reducing investment risk, particularly in relation to the SET50 index (as a representative of the overall capital market) and gold. Moreover, although measurements of hedging with the static model are considered to be a basic method (e.g. Holmes, 1996; Awang et al., 2014), this study sheds light on the time-varying models, which many studies (e.g. Dimitriu & Paun, 2012) believe to be a better method. In the following section, a review of the literature regarding hedge effectiveness and its measurement is made. A description of the methodology applied in the paper is then presented in section three, while the results and conclusion are discussed in the final two sections.

2. Literature Review

Theoretically, hedging is defined as a process to minimise portfolio risk. Many earlier studies of hedging (e.g. Cotter & Hanly, 2012; Wen et al., 2011; Awang et al., 2014; Bonga-Bonga & Umoetok, 2016) consider ascertaining the correct hedge strategies in two ways: first by finding the optimal hedge ratio, and second by measuring hedge effectiveness. This section therefore discusses these two approaches.

2.1 Hedge ratio and hedge effectiveness

The hedge ratio is defined as the percentage of an investor's portfolio which can be hedged on the hedged instruments to the value of the hedged assets. If the ratio generates the minimum portfolio variance, it is known as the optimal hedge ratio (Ederington, 1979). A ratio of 100%, or one, represents the position of being fully hedged, whereas a ratio of zero refers to an unhedged position. Hedge effectiveness is defined as a reduction in portfolio variance, taken from the calculation of the hedge ratio (Ederington, 1979). Consequently, the portfolio variances will be computed to capture the hedge ratio and hedge effectiveness. However, the optimal hedge ratios and hedge effectiveness may be different according to the time horizon and the methods used. Bonga-Bonga and Umoetok (2016, p.4000) explain that a highly effective hedged portfolio should be able to offset the changes in the fair value of the hedged item with the value of hedge derivatives.

An early study by Ripple and Moosa (2005) explains that the research on hedging via futures frequently addresses estimation of hedge ratios and hedge effectiveness. The measurement of hedge ratios in Ripple and Moosa's (2005) work is based on the slope coefficient in a regression of the rate of return on the unhedged position on the rate of return of the hedging instruments. This is consistent with later studies; for instance, those of Rao and Thakur (2008), Awang et al. (2014) and Bonga-Bonga and Umoetok (2016).

In addition, Rao and Thakur (2008) report that due to lower trading costs, derivatives are a better instrument for investors to reduce volatilities in their portfolios. Subsequently, Cotter and Hanly (2012) introduced two broad approaches to optimal hedging, as the consequence of hedge ratio measurements, namely the hedging estimation method which reduces the measurement of risk, and that which allows for asymmetry in return distribution. Their findings show that information asymmetry causes hedging performance to differ between the short and long positions of hedgers. Dimitriu and Paun (2012) developed Cotter and Hanly's (2012) work, showing that not only is risk reduced when hedging estimation methods are used, but also that the profitability of firms declines.

Later, several studies applied different hedging estimation methods (as initially mentioned in Dimitriu & Paun, 2012, for instance) to investigate hedge effectiveness via futures and options. Awang et al. (2014) collected data on stock index futures in Malaysia and Singapore to examine hedge effectiveness with a variety of estimation methods, such as ordinary least squares (OLS), the vector error correction model (VECM), exponential generalised autoregressive conditional heteroscedasticity (EGARCH) and bivariate GARCH (BGARCH). Their results demonstrate that the OLS model appears to be a suitable hedging measure due to the low transaction costs of the futures market. Using data from the South African equity and futures market, Bonga-Bonga and Umoetok (2016) reveal that there are differences in hedge effectiveness in different hedging horizons and with different hedge estimation methods. VECM and multivariate GARCH (MGARCH) are shown to be the best for the South African market. In Thailand, Amornsiripanuwat (2017) employed the SET50 options to capture hedge effectiveness employing the models of Black and Scholes (1973) and Wilmott (1994). His evidence shows that there is no significant difference in hedge effectiveness between these two options.

2.2 Hedge ratio and hedge effectiveness measurements

As discussed in the previous section, earlier research was conducted to ascertain hedge effectiveness when investing in derivatives. This section will present a review of the literature regarding how to measure hedge effectiveness by these methods. Two main measurements of hedge strategies are employed in previous studies, namely the static and time-varying models. Although some papers (e.g. Lee & Lee, 2012; Bonga-Bonga & Umoetok, 2016) claim that there are three strategies (namely the traditional native hedge, OLS and BGARCH), these were in fact based originally on the static and time-varying models. Nevertheless, it is important to choose the most suitable hedging strategies in an investment portfolio because "a good hedge effectiveness measure should assist investors to construct an effective hedge portfolio" (Bonga-Bonga & Umoetok, 2016, p.4000). OLS, sometimes known as the single equation method estimated by OLS (SEMOLS), is considered to be the simplest optimal hedge ratio. It was introduced by Ederington (1979), and developed by Holmes (1996), Cotter and Hanly (2012), Awang et al. (2014) and Bonga-Bonga and Umoetok (2016). Evidence shows that OLS serves as a better hedge model than other static and time-varying ones (e.g. Cotter & Hanly, 2012; Awang et al., 2014). In the case when spot and future prices are cointegrated in the long-run, VECM becomes more appropriate in the static model rather than OLS. Moreover, GARCH series (standard GARCH, EGARCH and MGARCH) are also brought into the measurement of time-varying optimal hedge ratios. These are specifically the conditional variance models (e.g. standard GARCH and EGARCH) and the conditional correlation, namely MGARCH. Choudhry (2003), Yang and Allen (2005) and Bhaduria and Durai (2008) confirm that GARCH appears to be a more effective model than OLS over a longer period, but not so in the short run relationship between spot and futures prices.

However, in another category of hedge strategy estimations, time-varying models, several studies demonstrate that they are a more powerful measurement than static models, such as OLS and VECM. These time-varying models include GARCH, EGARCH and MGARCH. Dimitriu and Paun (2012) indicate that time-varying models provides better results than static ones. This is also consistent with an earlier study by Laws and Thompson (2005), who used the exponential weighted moving average (EWMA) in relation to the time-varying model on the FTSE100 and FTSE250 futures indices and found the best estimate of optimal hedging. Furthermore, in the time-varying model, particularly with the application of MGARCH, Rossi (2012) suggests three additional approaches to constructing MGARCH models, namely direct generalisations, linear combinations and nonlinear combinations of univariate GARCH models. The methodologies included in these three approaches are Baba-Engle-Kraft-Krone (BEKK) developed by Engle and Kroner (1995), the Constant Conditional Correlation model (CCC), and Dynamic Conditional Correlation (DCC), developed by Silvennoinen and Teräsvirta (2008).

In addition, Syriopoulos et al. (2017) and Syriopoulos and Tsatsaronis (2018) introduced an alternative dynamic hedging model method. This is based on the OLS and rolling estimation of its coefficient during the study period. Syriopoulos et al. (2017) applied a variety of time-varying models to capture the difference in hedge effectiveness between freight derivatives and time charter in Greece. Their results demonstrated that applying rolling window OLS as a time-varying model of hedge effectiveness produced the lowest risk in the freight market, with the use of Forward Freight Agreements (FFAs). This rolling OLS is also used in the work of Syriopoulos and Tsatsaronis (2018), which focuses on finding the optimal hedge ratio and hedge effectiveness between seaborne trade and commodities markets in Greece.

2.3 Literature critique

Concerning the literature reviewed in the section two, some gaps are evident, which were key motivations for this study. First, this paper is an expanded study of derivatives in Thailand, as an emerging market. The previous works on Thailand of Wattanatorn (2014) and Amornsiripanuwat (2017) seem to be the only ones from the last decade to focus on hedge effectiveness in the country but concentrate only on the options market. This study will cover another derivative product, futures, since the TFEX has a greater variety of futures contracts than options, allowing this research on hedge effectiveness in Thailand to be fulfilled. Second, this study applies data from an emerging market, Thailand, and the results will be compared to establish whether they carry over from those obtained for developed and other emerging markets.

Finally, inconclusive results have been obtained in the current literature. For instance, in some studies OLS is claimed to be the best hedging model (such as Choudhry, 2003, Bhaduria & Durai, 2008 and Awang et al., 2014), particularly in the short term, while other works (for example, Dimitriu & Paun, 2012, and Bonga-Bonga & Umoetok, 2016) point out that time-varying models (i.e. MGARCH) demonstrate better hedging performance than static ones (e.g. OLS and VECM). This study will re-estimate the data from Thailand through both static and time-varying models, namely OLS and VECM for static models, and rolling OLS (as suggested by Syriopoulos et al., 2017 and Syriopoulos & Tsatsaronis, 2018), BEKK and DCC (as introduced by Silvennoinen & Teräsvirta, 2008) for the time-varying models included in the examination.

3. Data and Methods

3.1 Data collection

The study examines three main futures contracts on the TFEX, namely SET50 futures, gold futures and interest rate futures, during the study period of 2011 to 2018. The reasons for selecting these three futures contracts were due to the order in which each derivative product was traded on the TFEX and the availability of data. SET50 futures were the first derivative officially traded on the Thai financial market, in 2006. This was followed by SET50 options, single stock futures, gold futures and interest rate futures. With these products, it is possible to obtain data over a longer period. Although Basher and Sadorsky (2016) mention that oil provides the most effective hedge for emerging markets, using several methodologies, there is incomplete data for oil futures in Thailand. Therefore, gold futures and interest rate futures were selected for inclusion in the study sample.

Since gold and interest rate futures were first traded on the TFEX in late 2009 and 2010 respectively, balanced sample data would be preferred. This is because this study aims to focus on the period in which the three futures were fully traded. As a result, it is possible to make a comparison of the periods in which futures show the best hedge effectiveness. Therefore, the study period chosen was 2011 to 2018, meaning the data would be more recent and up to date, compared with those used in previous Thai derivatives literature, such as Wattanatorn (2014) and Amornsiripanuwat (2017). In addition, the three futures contracts (SET50 futures, gold futures and interest rate futures) are fully traded on the TFEX. All daily futures prices and the daily underlying prices were collected from Thomson Reuters DataStream in a time series version. In addition, the underlying asset of gold futures is the XAU 96.50%, whereas that of interest rate futures is the three-month Bangkok Interbank Offer Rate (3MBIBOR).

3.2 Methods

According to econometric concepts, time series data need to be stationary, otherwise cointegration has to be conducted (Maddala, 2001). Should the series reject the null hypothesis of cointegration, the error correction model (ECM) should be employed. In order to test for stationarity, the augmented Dickey-Fuller test (ADF) is performed (Brooks, 2008). Subsequently, according to the literature review, the estimations of hedge ratio and hedge effectiveness are applied via either static models or time-varying ones. For static models, there is only one value for both the hedge ratio and hedge effectiveness, while for time-varying models the hedge ratio and hedge effectiveness values show variations during the study period.

3.2.1 Static models

OLS is considered to be the simplest static model to capture hedge ratios and hedge effectiveness by estimating the regression coefficient and R-square, as proposed by several previous studies; e.g. Rao and Thakur (2008), Chang et al. (2011), Awang et al. (2014) and Bonga-Bonga and Umoetok (2016). The OLS calculations based on Awang et al. (2014) are shown in equation 1:

$$R_{st} = \alpha + \beta R_{Ft} + \varepsilon_t \tag{1}$$

where R_{st} is the spot return measured by $\ln\left(\frac{S_t}{S_{t-1}}\right)$, with ln representing the national logarithm; R_{Ft} is the future return measured by $\ln\left(\frac{F_t}{F_{t-1}}\right)$; β is the optimal hedge ratio measured by OLS; and ε_t is an error term in the OLS equation.

In equation 1, there are no control variables, which could lead to misspecification with oversimplification. Nevertheless, it is perfectly adequate for estimating hedge ratios and hedge effectiveness because the considerations are focused only on the hedge instrument (futures) and hedge item (spot).

However, some areas can be criticised in the application of OLS. First, when examining with this method, the changes in spot and futures prices are used to make the series stationary. This would be misleading in terms of spot and futures prices, which appear to move together in the same direction. Second, the hedge ratio could be biased if there is cointegration between spot and futures prices and the error correction term is excluded in the regression (Ghosh, 1993). This is certainly the case, since the characteristics of spot and futures price are cointegrated; i.e., they move in the same direction. Third, since spot and futures prices are reported daily, the hedge ratio should be dynamic. In order to avoid these three arguments, VECM (another static model) and time-varying models (such as GARCH series) are brought into the estimations of hedge ratio and hedge effectiveness.

VECM is considered to be the most appropriate measurement via the static model compared to OLS, particularly when the two series are cointegrated in the long run, as suggested by previous studies (e.g. Kumar, 2008; Awang et al., 2014; Bonga-Bonga & Umoetok, 2016). To apply VECM in this study, cointegration tests are consequently required for the examination of spot and futures series. Awang et al. (2014) and Bonga-Bonga and Umoetok (2016) reveal that if the spot and futures series are cointegrated of the order one, the VECM is given as equations 2 and 3:

$$R_{St} = \alpha_S + \beta_S S_{t-1} + \gamma_F F_{t-1} + \sum_{i=2}^{k} \beta_{Si} R_{St-i} + \sum_{j=2}^{l} \gamma_{Fj} R_{Ft-j} + \varepsilon_{St} \quad (2)$$

$$R_{Ft} = \alpha_F + \beta_F F_{t-1} + \gamma_S S_{t-1} + \sum_{i=2}^{k} \beta_{Fi} R_{Ft-i} + \sum_{j=2}^{l} \gamma_{Sj} R_{St-j} + \varepsilon_{Ft} \quad (3)$$

where S_t is the natural logarithm of spot prices; F_t is the natural logarithm of futures prices; and ε_{St} and ε_{Ft} are the error terms, which are independently and identically distributed (IID).

The optimal hedge ratio is then calculated via equation 4:

$$H = \frac{\sigma_{s,f}^2}{\sigma_f^2} \quad (4)$$

where H is the hedge ratio; $\sigma_{s,f}^2$ is the covariance of spot and future series; and σ_f^2 is the variance of futures.

Moving to the estimation of hedge effectiveness, which was originally introduced by Ederington (1979), measurement was made following the study of Awang et al. (2014), as shown in equations 5 to 9:

$$R_u = S_{t+1} - S_t \quad (5)$$

$$R_h = (S_{t+1} - S_t) - h'(F_{t+1} - F_t) \quad (6)$$

$$\text{Var(unhedged)} = \sigma_s^2 \quad (7)$$

$$\mathrm{Var(hedged)} = \sigma_s^2 + h'^2\sigma_f^2 - 2h'\sigma_{s,f} \tag{8}$$

$$\text{Hedge Effectiveness} = \frac{\mathrm{Var(unhedged)} - \mathrm{Var(hedged)}}{\mathrm{Var(unhedged)}} \tag{9}$$

where R_u is the return on an unhedged portfolio; S_t and S_{t+1} are spot prices at time t and t+1; F_t and F_{t+1} are futures prices at time t and t+1; h' is the (optimal) hedged ratio; R_h is the return on a hedge portfolio; σ_s, σ_f are standard deviations of the spot (s) and futures (f); and $\sigma_{s,f}$ is the covariance of spot and futures series.

3.2.2 Time-varying models

Referring to the criticism of OLS, the hedge ratio from static models (even with VECM) is constant over time, which is not dynamic along with the spot and futures prices. Therefore, time-varying models are introduced to calculate the hedge ratio, beginning with the simple one known as rolling OLS, as suggested by Syriopoulos and Tsatsaronis (2018). This model is the same as OLS (applying equation 1), except that the coefficients of the regression (which is the hedge ratio) rolls daily over time. Hedge effectiveness is still captured via the R-square, which also rolls over time. EGARCH is employed as the second time-varying model with conditional variance. Tangjitprom (2011) suggests that since volatility clustering exists in the Thai stock market, EGARCH appears to be a suitable proxy. A simple variance specification of EGARCH is given in equation 10 (Awang et al., 2014):

$$\log \sigma_t^2 = \omega + \beta \log \sigma_{t-1}^2 + \alpha \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \tag{10}$$

where ω, α, β are constant parameters; γ is a constant parameter and represents an asymmetric shock; and $\log \sigma_t^2$ is conditional variance.

Moreover, this study applies MGARCH models as the final time-varying model, covering both the conditional covariance and conditional correlation. These are specifically the BEKK model of Engle and Kroner (1985) and the DCC model of Engle (2012). The MGARCH models allow both covariance of spots and futures, and variance of futures (as a measurement of the hedge ratio in equation 4) which change over time. Therefore, estimation of the hedge ratio via MGARCH would reflect the time-varying nature of spot and futures prices.

4. Results and Discussion

4.1 Test for stationarity

With time series data, it is necessary to conduct a test for stationarity, in this case the ADF test. The results are shown in Table 1.

Table 1: Test for stationarity

Series	ADF statistics		ADF p-value
	Level	First Difference	(First Difference)
SET50 Spot	-2.0037	-45.3488 ***	0.0001
SET50 Futures	-2.0687	-47.5832 ***	0.0001
Gold Spot	-2.0335	-47.5790 ***	0.0001
Gold Futures	-1.9671	-34.6892 ***	0.0000
3MBIBOR Spot	-0.3908	-41.6728 ***	0.0000
3MBIBOR Futures	-1.2410	-46.8877 ***	0.0001

Note: The table shows the stationarity test results for the spot and futures prices of the SET50 index, gold (XAU 96.50%) and 3MBIBOR. The ADF statistics and p-values are tested at significance levels of 10% (*), 5% (**) and 1% (***).

In Table 1, the outcomes indicate that all series are stationary in the first difference form based on the estimation by ADF. Therefore, the analysed series ensure correct model specification (Bonga-Bonga & Umoetok, 2016).

4.2 Hedge ratios and hedge effectiveness in static models

According to Kumar et al. (2008) and Awang et al. (2014), cointegration tests need to be run prior to the estimation of VECM. Should the two series (namely, spot and futures return) be cointegrated, VECM will be applied in the study. Having conducted the cointegration test, the results shown in Table 2 clearly confirm that there is cointegration between spot and futures prices by taking the natural logarithm of both series to reduce their volatilities. Hence, VECM remains the choice for the measurement of the hedge ratio and hedge effectiveness in the static models. The overall results from the static models are presented in Table 3.

Table 2: Test for cointegration

Hypothesis	Eigenvalue	Maximum Eigenvalue Statistics	Trace Statistics
Panel A: SET50 index (log-likelihood = 16,069.74)			
r = 0	0.0134	28.1649 ***	33.0733 ***
r = 1	0.0024	4.9084	4.9084
Panel B: Gold (XAU 96.50%) (log-likelihood = 14,735.32)			
r = 0	0.0899	195.9252 ***	199.9891 ***
r = 1	0.0020	4.0639	4.0639
Panel C: 3MBIBOR (log-likelihood = 13,689.39)			
r = 0	0.0436	92.6656 ***	93.1105 ***
r = 1	0.0002	0.4491	0.4491

Note: The table shows the Johansen cointegration test for the natural logarithm of spot and futures prices on the SET50 index (Panel A), gold (XAU 96.50%, Panel B) and the 3MBIBOR (Panel C). The cointegration test is estimated with significance levels of 10% (*), 5% (**) and 1% (***).

Table 3: Hedge ratios and hedge effectiveness in the static models

	SET50 Futures	Gold Futures	3MBIBOR Futures
Panel A: Estimation with OLS			
Hedge ratio (β)	0.8878	0.2209	0.1384
Hedge effectiveness (R^2)	0.9325	0.0450	0.1100
p-value	0.0000	0.0000	0.0000
Panel B: Estimation with VECM			
Hedge ratio	0.8998	0.2338	0.1462
Hedge effectiveness	0.9920	0.4048	0.2452
p-value	0.0000	0.0000	0.0000

Note: The table shows the hedge ratios and hedge effectiveness in the static models estimated by OLS (Panel A) and VECM (Panel B), following Awang et al. (2014) and Bonga-Bonga and Umoetok (2016).

For OLS estimation, the results of the hedge ratios and hedge effectiveness show that investing in SET 50 futures is the most effective way to hedge for investment risk, with figures of 88.78% and 93.25% respectively (see Table 3 – panel A). For the other two futures contracts, 3MBIBOR futures perform better in hedging, with an effectiveness of 11.00%, whereas gold futures have the lowest hedge effectiveness among the three, at 4.50%. However, although gold futures display the lowest hedge effectiveness; their hedge ratio (represented by β in Table 3 – panel A) provides the second highest level in the sample, after SET50 futures (at 0.2209). This means that with SET50 futures, investors should hedge up to 88.78% of their investment, which would reduce their portfolio risk to 93.25%. In comparison with 3MBIBOR futures, only 13.84% of hedging in investors' portfolios is reported, but the reduction of risk is just 11%. This is even worse for gold futures. Consequently, SET50 futures show the best performance when measuring the hedge ratio with OLS.

For VECM, a cointegration test was run in order to confirm whether it can be applied in this study. The findings reveal that the two series of spot and futures prices are clearly cointegrated in all the futures utilised in the study (see Table 2 – all panels). All futures series have a cointegrating relationship with a rank of one (no rejection of the null hypothesis of $r = 1$; see Table 2). According to the cointegration test, VECM can estimate the hedge ratio and hedge effectiveness. The results show that hedge ratios estimated by VECM provide the same outcomes as the OLS findings, with SET50 futures giving the highest hedge ratio, at 0.8998 (see Table 3 – panel B), followed by gold futures (at 0.2338) and 3MBIBOR futures (at 0.1462). However, there is a slight difference in hedge effectiveness measured by OLS and VECM. The highest hedge effectiveness remains with SET50 futures (at 99.20%), with the second highest being gold futures at 40.48%, and 3MBIBOR futures third, at 24.52%, which is the lowest efficiency in this study (see Table 3 – panel B). This implies that with VECM, SET50 futures are the most effective way to reduce the variance in hedged items.

Consequently, VECM appears to be the best fit with the hedge ratio and hedge effectiveness measurement of Thai futures by the static models, due to the higher values compared to OLS. These findings are consistent with previous studies, supporting the notion that VECM provides a better hedging outcome in static models (e.g. Cotter & Hanly, 2012; Awang et al., 2014).

4.3 Hedge ratios and hedge effectiveness in time-varying models

For the time-varying models, four estimations, namely rolling OLS, EGARCH, BEKK and DCC, are utilised in this study. The results are shown in Table 4. There are several ways to compare these with the MGARCH models, besides the values of hedge ratio and hedge effectiveness; for example, by considering the correlations of standard deviation estimated by each model (e.g. Silvennoinen & Teräsvirta, 2008; Engle, 2002; Chang et al., 2011; Chevallier, 2012); by comparing the mean absolute errors or predictive accuracy (e.g. Lypny & Powallo, 1998; Su & Huang, 2010; Wattanatorn, 2014); or by the level of log-likelihood (e.g. Silvennoinen & Teräsvirta, 2008; Acatrinei et al., 2013). For this study, the use of log-likelihood appears to be the simplest interpretation and is therefore employed.

Table 4: Hedge ratios, hedge effectiveness and log-likelihood in time-varying models

Estimation	SET50 Futures	Gold Futures	3MBIBOR Futures
Panel A: Hedge ratios and hedge effectiveness			
Rolling OLS	0.9047	0.1093	0.0784
	(0.9051)	(0.1669)	(0.2243)
EGARCH	0.8945	0.2374	0.1353
	(0.9301)	(0.0724)	(0.1010)
BEKK	0.8962	0.0664	0.0499
	(0.9206)	(0.2294)	(0.1152)
DCC	0.9009	0.2362	0.1366
	(0.9259)	(0.0485)	(0.1033)
Panel B: Log-likelihood values			
Rolling OLS	9,399.89	6,911.24	7,805.43
EGARCH	9,595.75	7,113.99	7,981.76
BEKK	16,234.31	14,283.17	13,972.21
DCC	16,259.87	14,315.10	3.33

Note: The table shows the hedge ratios, hedge effectiveness and the log-likelihood for the rolling OLS, EGARCH and the MGARCH models (namely BEKK and DCC) as the time-varying models among the three series of futures: SET50 futures, gold futures and 3MBIBOR futures. Panel A shows the hedge ratios and hedge effectiveness (presented in parentheses) under the rolling OLS, EGARCH, BEKK and DCC models. Panel B shows the log-likelihood of rolling OLS, EGARCH, BEKK and DCC, following the paper by Acatrinei et al. (2013).

The results from the time-varying models demonstrate that SET50 futures are the most effective hedging instrument for futures in Thailand, followed by gold futures and 3MBIBOR futures. SET50 futures are shown to have more than 90% hedge effectiveness (see Table 4 – panel A) and the highest hedge ratio, compared to the other two. These findings demonstrate that SET50 futures have the best performance in reducing portfolio risk, since their hedge effectiveness is highest when the time-varying models are employed. Moreover, gold futures appear to produce slightly different results if different models are used: e.g. BEKK and DCC. Investors could have a low hedge position in their portfolios and have up to 22.94% of hedge effectiveness via the BEKK, with the reverse true when applying EGARCH or DCC. In addition, these findings in relation to time-varying models (namely rolling OLS, EGARCH, BEKK and DCC) are consistent with the results from the static models.

With reference to Table 4 – panel B, according to Acatrinei et al. (2013), the higher the log-likelihood, the better the hedge effectiveness. Consequently, SET50 futures remain the most suitable futures instrument for hedging in Thailand. Their log-likelihood is displayed as 9,399.87 for rolling OLS, 9,595.75 for EGARCH, 16,234.31 for BEKK and 16,259.87 for DCC, which are higher values than those of gold and 3MBIBOR futures. Nevertheless, 3MBIBOR futures appear to display the lowest hedge effectiveness of the three series estimated in this study, but only when DCC is applied. This would be because DCC focuses on forecasting conditional correlations rather than conditional covariance (Caporin & McAleer, 2010). Furthermore, since all the log-likelihood values, together with hedge ratios and hedge effectiveness, of the DCC model (apart from those in 3MBIBOR futures) are higher than those of the rolling OLS, EGARCH and BEKK models, they are consistent with the current literature (e.g. Engle, 2002; Basher & Sadorsky, 2016), which consider that DCC is a better fit and the most accurate method in time-varying models.

5. Conclusion

Since investors in general are known to be risk averse, their investments need to be less volatile, but the expected returns the same. The application of derivative instruments to hedge against investment risk would support their requirements. This study provides empirical evidence of hedge effectiveness in Thailand, focusing on three futures series, namely SET50 futures, gold futures and interest rate futures, during the period 2011 to 2018. The selection of futures was based on the period in which they were listed on the TFEX, together with the existence of a balanced panel of data, in order to compare with the same period, and that they were fully trading on the TFEX. The methods were estimated with both static and time-varying models. The results suggest that SET50 futures are the most effective hedge on the TFEX, followed by gold and interest rate futures. The findings are robust, both for the static and time-varying models. Moreover, they are consistent with previous studies (e.g. Cotter & Hanly, 2012; Awang et al., 2014; Basher & Sadorshy, 2016; Bonga-Bonga & Umoetok, 2016). As a result, by hedging in SET50 futures, investors would be able to reduce their investment volatilities relating to the composite index, such as a passive equity fund which generates returns similar to those of the SET50 index. For other assets, such as gold and interest rates, the empirical evidence suggests that they have no significant value for hedging due to their low effectiveness. Moreover, although SET50 futures are shown to be the best hedge instrument in this study, it is impossible to have a 100% hedge in practice. Investors should diversify their investments to minimise their risk according to their preferences.

However, because of the limited variety of derivative products on the TFEX, and since these products are new to the market, this means that the study is limited in some areas. For example, it would benefit from the advantage of a longer study period and additional series of underlying assets. It has been clearly shown in the study that investors may benefit from hedging via the composite index, rather than through individual stocks or other types of financial assets such as commodities, interest rates or exchange rates. Therefore, a comparative study between Thailand and other emerging markets would provide interesting evidence in the areas in which Thai data is applicable, as would examining derivative products in the country over a shorter period, since they have only been established in the last decade; for example, the past one or two years. This would provide a better view of investment strategies in the short term.

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